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MORTGAGE STUDY REPORTS

Report #3

RELATIONSHIPS BETWEEN THE MORTGAGE INSTRUMENT,
THE DEMAND FOR HOUSING AND MORTGAGE CREDIT:
A REVIEW OF EMPIRICAL STUDIES

J. Kearl*, K. Rosen**, C. Swan***

SSM WP#748-74

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I. INTRODUCTION

This task of the study is concerned with reviewing the existing literature in an attempt to understand how changes in the mortgage instrument would affect the demand for housing and the demand for mortgage credit. As illustrated by the discussion in Task II, changing the mortgage instrument in response to inflationary factors can be expected to affect the following aspects of housing finance,

- 1) interest rates
- 2) downpayment requirements
- 3) amortization period
- 4) initial monthly payment (which in a conventional mortgage is determined by 1-3)
- 5) time path of real payments.

Our survey of the literature has been structured to evaluate the evidence about the impact of these parameters of the mortgage instrument on the demand for housing and mortgage credit. Our discussion places a heavy emphasis on econometric models of housing activity and the demand for mortgage credit. This paper is organized as follows. The next section of the paper presents a brief overview of the existing literature on the

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demand for housing and for mortgage credit. This discussion is designed to introduce the reader to the literature and place work in a historical context emphasizing major themes and conflicts.

Section III reviews the results of Task II and develops a general framework for analyzing housing and mortgage markets. This discussion is necessary since much of the existing literature lacks a cohesive theoretical framework and does not deal directly with some of the proposed alterations of the existing mortgage instruments.

The fourth section presents a more detailed discussion of numerous models with an emphasis on the effects of changes in those parameters of the mortgage instrument which distinguish alternative possible instruments to finance housing, detailed in Task II. The penultimate section presents a series of charts that offer schematics of the models surveyed as estimated, and will hopefully serve as a source of comparison of structures. Both housing models and models of mortgage demand are included.

The last section of the paper is a bibliography of the relevant literature with annotations for all the major modeling efforts.

A. Short-run Vs. Long-run Behavior

Most of this literature is of relative recent vintage (within the last fifteen years) and on housing and mortgage credit much of it is concerned with explaining post-war cycles as measured by quarterly data. There is thus a heavy emphasis in the literature on explaining short-run behavior. Some work, but by no means all, places the explanation of short-run behavior squarely in a model with long-run stock equilibrium properties. Most studies, however, concentrate on short-run flows without explicit treatment

of long run equilibrium considerations. This emphasis on the short-run as opposed to the long-run has its advantages and disadvantages. A major advantage is the general belief, supported by many of the studies we have surveyed, that financial type variables and credit rationing have their major impact on short-run flows. There is a train of thought that holds that the long run stock demand for housing is primarily a function of income, relative prices, the rental rate of housing services, and the size and age-structure of the population. Monetary policy and the parameters of the mortgage instrument may have little, if any, impact on these basic demand factors. However, adjustment of the stock, that is, how quickly equilibrium is approached, does seem to be strongly influenced by monetary policy and the parameters of the mortgage instrument. Thus a survey of this literature may prove useful in assessing possible changes in the mortgage instrument.

A major disadvantage of the emphasis on short-run flows is the consequent lack of attention paid to long-run implications. For example, increases in the loan-to-value ratio are usually expected to have a positive impact on the level of housing starts and the demand for mortgage credit. (For example see 35, 43). What is ambiguous in most studies is how long such a positive effect is expected to persist. The higher flows will result in a larger stock of both houses and of total mortgage debt outstanding. Does the change in the loan-to-value ratio mean that there will be permanently larger stocks of houses and mortgages, or does it mean that the economy reaches an unchanged stock equilibrium sooner?

Most short-run studies are not designed to answer this question.

The distinction between short-run and long-run behavior is an important one to keep in mind. Proposed policy changes may well have effects on both sorts of behavior. Care must be taken not to draw inferences about long-run behavior from studies that are designed to capture mainly short-term effects.

II. AN OVERVIEW OF THE LITERATURE

A. Models of Long-Run Behavior

A major part of the literature on housing reflects a long history of debate concerned not with cyclical fluctuations in housing, but with price and particularly income elasticities of the demand for housing services. The demand for housing services is usually translated into a derived demand for the stock of houses. Research was stimulated by the findings of Grebler et al [32] of a remarkable decline in real capital investment in housing despite changing financial positions and increasing real income. Lee [48], Winger, Reid [62], Muth [61] and others, using both cross section and time series data, have reported widely differing income elasticities, ranging from .65 to 1.7. deLeeuw [17] has recently attempted a reconciliation of these studies by analyzing carefully the varying data used. deLeeuw has concluded the income elasticity of the demand for housing is most likely in the .8-1.0 range - higher for owner occupied than for rental housing. This did not resolve the issue, however, since Maisel et al [54] have claimed that grouping of the data led to an upward bias in the estimation of the income elasticity of demand.

They conclude that the income elasticity of demand is substantially lower most likely in the range of .62-.7.

This research effort on income and rental rate elasticities has concentrated primarily on long-run equilibrium impacts, where income and rental rate changes lead to a new, long run equilibrium in terms of the stock of houses. Financial variables were generally not included in these studies, certainly not the wealth of financial variables that have appeared in recent econometric models of short run cycles in housing starts. The implication of the absence of financial variables is that they are not (or were not considered) important in the determination of the long-run equilibrium.

It is important to note this distinction, since the subsequent concentration of research on housing cycles tended to obscure the distinction between the long-run and short-run impacts of various economic variables. As a result, the distinction between equilibrium responses and short-run adjustment impacts has not always been clear.

B. Models of Cycles in Housing Investment And/Or Housing Starts

Turning now to models of cycles in housing investment, Guttentag [33] and Alberts [1] were among the first researchers to emphasize the role of mortgage credit in the housing cycle. The arguments were relatively simple. Mortgages are a source of residual investment to many financial institutions. During periods of tight credit conditions, there is not much money for residual investments. Consequently, the flow of funds into the mortgage market falls off dramatically, leading to higher mortgage rates. Income effects on housing demand are dominated by the

cost-of-credit effect. Thus the cycle in interest rates causes a cycle in mortgage lending and home building.

A contributing factor to the abrupt changes in funds available for mortgages could have been the fixed interest ceiling on government insured (FHA) or guaranteed (VA) mortgage loans. A number of "fixed-rate theorists", Guttentag [3], Lewis, Smith [69], Schaef [63], and Grebler [29] advanced this argument. Alberts [1] argued that discounting was an effective way to get around ceilings. In recent years, the fixed rate theory has not enjoyed much popularity among researchers as a major explanation of cycles although some elements of the fixed rate view can be found in work by Brady [6] and Clauretie [13]. This may be due, in part, to frequent ceiling changes in response to changing interest rates.

Maisel's studies for the Brookings model [52] were some of the earliest efforts at explicit modeling and estimation of postwar cycles in home building. Maisel's work emphasized demographic factors, measured as household formation, as a basic determinant of demand. Short cycles were seen as coming from the supply side as the result of an inventory response by builders. The only financial variable appearing in this work was the treasury bill rate. Subsequent work in this tradition is represented by Sparks [73] and Huang [35].

Subsequent work by Maisel and much of the recent work on housing cycles have emphasized the availability of mortgage credit as an important determinant of home building in the short run. Implicit in much of this work is the view that the mortgage rate is not a sufficient indicator of the state of mortgage markets; that one may not be able to get a mortgage

loan at existing mortgage rates; that some form of credit rationing is an important element in housing markets in the short run.

In the early 1960's, in a review of the literature for the Commission on Money and Credit, Grebler and Maisel [31], concluded:

"While these analyses differ on matters of emphasis and detail they agree in the conclusion that short-run fluctuations in residential building have resulted mainly from changes in financial conditions labeled borrowing, availability of mortgage funds, supply of mortgage credit.....No matter how housing problems are defined, credit has almost invariably been singled out as the key to the solution."

A decade later, after considerable research, Friend wrote [27],

"The greater impact of monetary stringency on housing than on the rest of the economy apparently is due mainly to a capital rationing effect, resulting from deficiencies in current institutional arrangements for providing mortgage credit; and probably also to an interest rate effect, reflecting a greater interest elasticity of housing demand than of demand generally."

There are two major elements to the view that concentrate on the importance of mortgage credit. One element is the importance of mortgage credit to the purchase of housing units. The other element is the belief that mortgage markets are often in disequilibrium and that the mortgage rate is not a complete measure of the availability of mortgage credit.

In his 1968 paper, Friend [31] speaks to the first point, the importance of mortgage credit:

"The reasons for expecting monetary shifts to influence housing starts are clear. By its nature, monetary policy should, in the first instance, affect those units whose spending is highly dependent on either the cost or the availability of credit. Among these groups, the degree

of impact will vary. The variations will depend on the proportion of purchases made with credit, the amount of credit required per unit of expenditure, the ability or willingness to absorb higher interest rates, the institutional character of the market, and the degree to which traditional lenders are influenced by policy changes. Housing ranks high in sensitivity to monetary policy on all these counts."

An emphasis on the availability of mortgage credit appears in a number of studies in different forms. Brady [6,7] and Huang [35] have included measures of loan-to-value ratios and amortization periods in housing starts equations. A number of investigators have included some sort of quantity measure of mortgage supply or possible supply. Maisel [51] includes a measure of the inflow of funds to financial institutions and a measure of FNMA purchases. Sparks, [73] after some substitution to eliminate a term for credit conditions, includes a quantity measure of mortgage acquisitions and commitments. Brady [7] has used mortgage commitments at life insurance companies as a determinant of FHA and VA starts. In later work, Brady [8] uses FHLB advances to help explain total starts. In Swan [76], the inflow of funds to savings institutions is the prime determinant of housing starts. The MPS [60] model includes a variable measuring the change in mortgage commitments.*

The Bosworth-Dusenberry [5] model uses current and lagged net changes in the stock of mortgages. URI [14] includes a measure of mortgage commitments as well as changes in the stock of mortgages.

* As detailed below the mortgage market of the MPS model is estimated in a way that allows for possible disequilibrium and credit rationing.

All of the above studies have added measures of credit availability to essentially single equation explanations of housing starts. Other work has attempted to estimate both demand and supply curves for housing starts. In one of the earliest efforts, Huang [35] includes FIMA mortgage purchases as a determinant of the supply of VA starts. Savings flows at S&L's and FHLB advances are seen as influencing the supply of conventional starts. In more recent work, Kearn & Rosen [43] include the net change in total residential mortgages as a determinant of the supply of total starts.

In some interesting work, Fair [24] has developed a monthly model of housing starts that not only includes savings flows as a determinant of the supply of starts but also explicitly allows for market disequilibrium and the failure of the mortgage rate to always be a market clearing rate. Swan [76] has followed up on Fair's original work with a quarterly disequilibrium model with similar qualitative results.

A brief summary to much of this work is provided by Gramley [23] who, in summarizing a massive Federal Reserve Study of fluctuations in residential construction notes:

"...observed short-run swings in housing starts over the post-war period reflect principally the impact of changes in financial variables on residential home-building. This aspect must become an integral part of the traditional wisdom..."

The general conclusion reached by most of these studies was that both cost and availability of credit are important determinants of short-run fluctuations in housing activity. A vocal dissenter to much of the

tradition represented by the preceding work is Meltzer [34]. He argues that this conclusion is simply wrong.

"Public policy toward housing is based on the conjecture that the "availability" of mortgage credit is an important--perhaps the most important--determinant of the demand for housing. Policy appears to be misconceived. We have found no evidence that the availability of the particular type of credit has any important or lasting effect on the type of assets individuals acquire. If the housing market is the market in which "availability matters" or matters most, there appears to be very little if any empirical basis for the conjecture or the public policies based on it."

A good deal of confusion surrounding Meltzer's position seems to arise from a failure to distinguish between short-run adjustment behavior and long-run equilibrium. Meltzer uses long time series of annual data whereas most of the analysts mentioned above use post-war quarterly data.* It is unlikely that few, if any, of the researchers who found evidence of credit rationing would argue that the availability of mortgage credit would have a substantial impact on the long-run equilibrium size of the housing stock. They are instead more concerned with cyclical fluctuations and feel that the availability of mortgage credit is an important short-run constraint.

* See Swan [80] for a detailed critique of Meltzer's major empirical effort.

C. Demand for Mortgage Credit

Most early post-war studies of mortgage markets emphasized the supply of mortgage credit from financial institutions. Klamon's NBER monograph [46] is a good example. Entitled The Postwar Residential Mortgage Market, the study has a complete discussion of trends and changes in the mortgage instrument including the composition of mortgages as between type of mortgage and type of structure, the behavior of the major mortgage lending intermediaries, and the rise of mortgage companies. The formal discussion of the demand for mortgage credit takes less than one page and emphasizes the strong pent up demand for housing following World War II.

Most formal modelling efforts of the demand for and supply of mortgages date from the mid-sixties. Huang's 1966 study is the earliest included in out discussion.

Almost all studies emphasize the demand for houses or housing starts as the major factor affecting the demand for mortgage credit. This emphasis is surely not surprising given traditional collateral requirements. The studies we have surveyed differ as to whether they include a measure of the stock of houses or the flow of housing starts. These studies also differ as to how they measure either the stock or the flow. In particular, some studies include an explicit measure of the stock of houses or the flow of housing starts. Other studies use only an implicit measure of housing by including terms such as income and prices to represent the basic demand for houses.

The choice of an explicit or an implicit measure of housing activity has at least two implications. One implication is the interpretation of coefficients on other variables in the equation for the demand for mortgage credit. For example, consider the mortgage rate. A change in the mortgage rate will have a direct effect on the demand for mortgage credit. ~~For example, consider the mortgage rate. A change in the mortgage rate will have a direct effect on the demand for mortgage~~ credit as the change in the mortgage rate affects peoples' desired equity position in houses. Note that this effect will occur with an unchanged level of housing activity measured on either a stock or flow basis. In addition, to the extent that the change in the mortgage rate affects either the amount of homebuilding or the desired stock of houses, there will be a further indirect effect on the demand for mortgage credit. In models with an explicit measure of housing activity, the coefficient on the mortgage rate measures only the direct effect of mortgage rates on the demand for mortgages. (The indirect effect is already captured in the explicit measure of housing activity.) In models with only implicit measures - i.e. the basic determinants of housing activity-- the coefficient on the mortgage rate captures both the direct and indirect effects of the mortgage rate on the demand for mortgages.

There is a further implication of using an explicit or implicit measure of housing activity. Implicit measures have tended to be justified on the grounds that they measure the desired amount of housing. If credit rationing is an important phenomena there may well be times when the actual stock of houses or amount of homebuilding is less than desired. Thus, while people want more housing and hence would like more mortgage credit, they are unable to get more housing and their

effective demand for mortgages may well be reduced. This possible distinction between desired and effective demands raises the further question of possible disequilibrium in mortgage markets and how one allows for any disequilibrium when estimating. Of the studies we have surveyed only Jaffee [38] directly incorporates possible disequilibrium into the specification of his model. Jaffee assumes that the mortgage market is always characterized by excess demand.

Virtually all the studies we have looked at use a measure of the flow of mortgages as the dependent variable. However, some studies use net flow data while others use gross flow data. Some studies use data on total mortgage flows while other studies disaggregate by either type of structure--1-4 family or multi-family--or by type of mortgage--FHA, VA or conventional. Besides these data differences, only a few studies--Silber [65] Jaffee [38], and Data Resources [14]-- are formulated in a long run framework with explicit long-run stock equilibrium implications. All these studies include a measure of lagged stock of mortgages in a partial adjustment framework. In the other studies the implications of the cumulation of past flows does not play an explicit role in the equations. These other studies do not include any measure of the lagged stock of mortgages.*

The three studies formulated with explicit long run equilibrium properties include either the stock of houses either explicitly or implicitly by the inclusion of the determinants of the demand for the stock of houses. The other studies, which do not have explicit long run

*The precise role of the stock of mortgages in Huang's work [35] is difficult to sort out. Huang's equations do include the lagged mortgage stock. However, the lagged stock appears in ratio form divided by the total holdings of financial assets.

equilibrium properties are more varied as to how they treat the demand for housing. In particular, some of these "flow" models of the demand for mortgage credit include measures of the flow of housing activity while other "flow" models of the demand for mortgage credit include variables that represent the demand for the stock of houses. The Flow-flow models include Huang [35] who uses the value of housing starts; Sparks [73] who uses variables that determine housing starts in his model; and Kearn and Rosen [43] who use the number of housing starts. The flow-stock models include Huang and Clauretie [13] who use variables that appear to represent the demand for the stock of houses in a strictly flow mortgage demand equation.

Almost all studies have used the mortgage rate as the price variable that affects the demand for mortgages. For models with an explicit measure of housing activity the coefficient of the mortgage rate measures the direct effect of mortgage rates on the demand for mortgage credit which is in addition to any effect the mortgage rate might have on housing activity.^{*/} For models with an implicit measure of housing activity, the coefficient of the mortgage rate is meant to capture both the direct activity. Only a few studies - Jaffee, Kearn and Rosen and DFI - include other interest rates. All these models include some measure of the corporate bond rate although the DFI model also includes a measure of rates paid on deposits at savings institutions.

* Huang's work for the Friend study [35] is the one paper that does not include the mortgage rate in the mortgage demand equation. The mortgage rate does enter the equation indirectly through its effects on housing starts.

For most studies, the mortgage rate is the only direct element of the mortgage instrument that is included. Jaffee recognizes that other elements of the mortgage contract would be expected to influence the demand for mortgage credit, but he does not include them in his equation citing negative findings of earlier authors and possibly bad data. It is interesting that Jaffee subsequently finds evidence of incomplete adjustment of mortgage rates resulting in short-run credit rationing. It is possible that some or all of this effect might have been caught by the inclusion of non rate terms. Silber reports that he attempted to include both the loan-to-value ratio and the amortization period. He says that multicollinearity forced him to include only one term. However, in his preferred equation, estimated by first differences, neither term appears. Huang has experimented with both terms. His 1966 and 1967 studies use the change in the amortization period. This variable is found to have a strong positive impact in both studies. Huang's 1969 study uses a constructed variable called per annum payment that is the quotient of the loan-to-value ratio and the amortization period. The coefficient for the per annum payment is negative in all equations for FHA, VA and conventional mortgages. The interpretation of this coefficient is a bit difficult as one would expect that both terms in the ratio would have a positive impact on the demand for mortgages.

The Clauretie study includes all three parameters of the mortgage contract - the mortgage rate, the loan-to-value ratio and the amortization period. Clauretie estimates equations for both net and gross mortgage flows,

for 1-4 family and multi-family mortgages and for conventional and government insured mortgages. The coefficients on the mortgage rate terms always have their expected sign - the mortgage rate coefficient is negative and both the loan-to-value ratio and the amortization period coefficients are positive. The Clauretje study is potentially very valuable for examining the impact of changes in mortgage terms. However, there appears to be a basic misspecification in the Clauretje study that raises some question about the interpretation of the effects of the mortgage contract terms. All of Clauretje's equations deal with the flow of mortgage credit. No measure of the stock of mortgages appears in any equation, yet Clauretje's measures of housing demand - income, relative prices and a population variable - are clearly related to the demand for the stock of houses, not the flow of new houses. This misspecification is perhaps reflected in Clauretje's problems with these variables. They are frequently of the wrong sign, statistically insignificant, or have been dropped from an equation.

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Research and analysis of housing problems have rarely been concerned with the nature of the mortgage instrument, except for the interest rate characteristics. The widespread use of government insured or guaranteed mortgages after the Depression may have changed the risk of mortgage and consequently, the interest spread between mortgages and other debt instruments. However, basic qualitative features of the mortgages have remained virtually unchanged, since the use of the current mortgage instrument began in the 1930's.

Except for a possible link with the interest ceilings on government backed mortgages, the relationship of the mortgage instrument and housing cycles has not been investigated. This is probably due to the unchanged characteristics of the instrument over the post-World War II period and relatively low rates of inflation over the same period.

The current method of financing the acquisition of housing - the long-term, fully amortized, level payment mortgage is a product of the Depression. Although savings and loan associations offered this type of mortgage for some time prior to the 1930's, its general acceptance was facilitated by a series of government actions in the housing-mortgage sector.*

The Home Owners' Loan Corporation, instituted in 1933, was created to refinance mortgages in default and eventually did so for more than one million home owners. Mortgages assumed by HOLC were converted from straight (primarily 3-6 year) mortgages, to fully amortized loans. Following this action, the Federal Housing Administration (FHA) was created. FHA insured loans were also fully amortized and had long-term maturities

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See Thygeson [81] for a more detailed history.

and relatively low downpayments. Later VA guaranteed loans were offered under essentially the same framework. Other lenders tended to follow this mortgage form of fully amortized mortgages. Over time both the length of the amortization period and the loan-to-value ratio increased.

There is some notion that the movement toward fully amortized, long-term mortgages in the 1930's represented a substantial change for housing. However, Grebler, et al [32], found that, at the end of the 1950's, there had been no substantial changes in the growth of housing stock since the turn of the century, despite the liberalized financing arrangements.

These findings and other analysis have led a number of analysts to suggest that financial variables other than the real rate of interest have no impact on the demand for housing. Characteristics of the mortgage instrument itself have, to a large extent, been ignored. Therefore, it is alleged that pure inflation induced changes in nominal interest rates should have no effect on the demand for housing. This particular view is presented again in a recent article by Arcelus and Gelter [2]:

"If market rates rise and are expected to remain permanently at their new level as the result of an increase in the anticipated rate of long-run inflation, there is no reason to believe that the demand for housing is permanently reduced....[It is only] at higher real rates [that] fewer houses are built." Perfect adjustment of financial markets have, in this view, no impact on the stock demand for housing."

While Meltzer has often argued against the conventional wisdom, his position on the neutrality of inflation induced changes in nominal interest rates is probably a fair statement of the current conventional wisdom among economists.

However, with the current method of housing finance, there is good reason to believe that inflation induced changes in the nominal rate of interest will have effects on housing demand. The conditions for neutrality or no effects would seem to be quite stringent.

We would like to suggest that, at least over short periods of time, both nominal and real interest rates are important determinants of the demand for housing and that the time path of actual income, not just permanent income, also plays an important role. They apparently do so, at least in part, because of the structure of the mortgage instrument.

The relationship between these nominal variables and housing is quite simple: the ratio of monthly nominal mortgage payments to monthly nominal income at the time the mortgage contract is secured is a key determinant of the mortgage size. To some degree this is the result of constraints currently imposed on the mortgage contract by law, tradition and market imperfection. However, the amount of monthly income allocated to housing is also constrained by household choice.

*This section is based on Poole [25]. Examples have been freely adopted from Tucker [82], McElhone and Cassidy [57], and Modigliani [59].

However, with inflation and/or real growth in income, the real burden of a home purchase is unevenly distributed over time. This uneven distribution of real payments may lead to distortions in the housing market.

Home purchases made by younger households are often constrained or eliminated by their current income and wealth. Established payment-to-income ratios (institutional rules-of-thumb) and down payment requirements may well limit the amount of housing a young household can purchase. The resulting level payment stream of the traditional mortgage establishes a time path of debt service that is at variance with most life cycle income paths. High transactions costs and imperfect information may subsequently work to lock this household into a particular dwelling unit. This distortion persists unless the household is willing and able to engage in costly "trading-up" transactions. Households, whose real financial position will, in fact, improve over time, find that current income constrains their ability to purchase as much housing as their expected income might allow. Even in a zero inflation world, current income constraints ignore the general trends in productivity and life cycle phenomena of rising incomes in general and incomes rising with age in particular.*

* Such considerations are presumably behind the recent Federal Home Loan Bank Board ruling allowing up to five years of interest only payments by qualified borrowers.

The problems deriving from a mortgage instrument that calls for constant payments in the face of an increasing trend in income may well be exacerbated by inflation. The existing mortgage instrument calls for constant nominal payments. If nominal interest rates rise in the expectation of future inflation, the conventional mortgage instrument will call for higher nominal payments now and over the life of newly issued mortgages. However, it is only in the future that inflation will deliver the higher nominal income with which to make the higher nominal mortgage payments. Households, whose real financial position does not deteriorate, may find that inflation makes it virtually impossible for them to purchase as much housing as in a non-inflationary environment.

Inflation and the adjustment of nominal interest rates has other effects on home buyers. To illustrate these effects, imagine the purchase of a home of some fixed cost with an associated mortgage in both an inflationary and inflation-free world. The nominal present discounted value of the mortgage must be the same in both the inflationary and inflation-free worlds. The higher nominal interest rate in the inflationary world, implies a higher discount factor for future nominal payments. The result is a higher initial payment, a higher initial payment to income ratio and a faster accumulation of equity than in the world of stable prices.

The inflationary world combines a constant nominal mortgage payment stream with a continual rise in prices. Consequently, real mortgage payments decrease through time and will eventually fall below those of the non-inflationary world. As the household makes level nominal payments with inflated dollars, effective shortening of the mortgage contract may well distort the household's housing decisions.

$$H_1^* = \frac{a_1 c_2 + b_2 c_1}{b_1 b_2 - a_1 a_2} \quad (5)$$

$$H_2^* = \frac{a_2 c_1 + b_1 c_2}{b_1 b_2 - a_1 a_2} \quad (6)$$

We can depict the conditions (3) and (4) as two lines in a two-dimensional graph. Suppose these are drawn as in Fig. 2, where the slope of line (3) is steeper than that of line (4) ($a_2/b_2 < b_1/a_1$). In this case, the hostility levels of the two organizations converge to an equilibrium point. This convergence can be shown by the following reasoning. If the initial state of conflict can be described by point A (hostility of organization 1 is \bar{H}_1 , that of organization 2 is \bar{H}_2) we have $\frac{dH_1}{dt} > 0, \frac{dH_2}{dt} < 0$. Namely, for organization 1, its hostility level at A is too low for the given hostility level of organization 2. Organization 2, on the other hand, regards its level of hostility at A is too high for the hostility level of organization 1. Therefore organization 1 tries to adjust by raising its hostility level and organization 2 by lowering it. Therefore the system tends to move to the state which can be represented by a point south east of A. This move of the system will continue until the state of the system is located north west of the both lines. At D, where the trajectory and the line $\frac{dH_2}{dt} = 0$ cross, we have $\frac{dH_1}{dt} > 0, \frac{dH_2}{dt} = 0$. Therefore for organization 2, its level of hostility matches that of organization 1, whereas organization 1 still regards its hostility level as too low for that of organization 2. Therefore organization 1 continues to expand its hostility while organization 2 is in an equilibrium

The tilting effect caused by inflation, results in a higher real initial payment. Even though this real payment declines with time (in a world with inflation), it may be a considerable period before the real payments fall below the real level payments that would exist in a no inflation world with the conventional mortgage instrument, where both payment streams were financing the same sized initial mortgage.

This spread between the (declining) real payments in a world with inflation and (level) real payments in a world with no inflation creates a gap that persists until the declining real payments equals the real level payments of the no inflation environment.* If the household is to obtain the same mortgage in each world and allocate the same proportion of its budget to housing, it must finance this gap over that time. Otherwise, it must either increase the proportion of income allocated to housing (if possible) or reduce the amount of housing purchased.*

* See Poole [25].

Suppose a family budgeted 25% of its income to house payments.

With a modest 2% inflation (5% nominal interest) a \$20,000 annual real income and a 30 year mortgage, the family could afford a house priced at \$77,600 with no initial equity required. They could, of course, afford even a higher priced home if any down payment was made. With the 6% inflation illustrated above, the \$77,600 home now requires 37.5% of their income for initial payments, although only 8% for the terminal payment. To reduce the payments to equal those with a 2% inflation would require a down payment of one third of the mortgage value.

The forced equity buildup means that while, with a 5% mortgage in 15 years, 40% of the home value is owned by the household, with a 9% mortgage, equity accumulation, in the same time period is 60% of the value of the home.

Tucker notes that because of this phenomenon, the average worker in 1973 can afford less housing in the new home market than he could in 1965 despite an 11% real income difference. We are left with the rather perverse result that a rising real income in an inflationary period may buy less housing services.

This phenomenon could obviously have no impact if the gap could be financed at the market interest rate. If it could be financed, the household could level the payment stream or indeed create a payment stream that varied through time. The essence of the constraint is that the gap cannot be financed. If there were no such constraint, the supply of funds will be sufficient only if lenders reinvest the difference between the real and nominal return. Otherwise the real value of capital is not maintained and the supply of funds will fall short of demand.*

* See Toole [45].

IV-THE INFLUENCE OF MORTGAGE INSTRUMENTS

The preceding discussion strongly suggests that the demand for houses may well be influenced by more than permanent income and/or net worth, relative prices and real interest rates. In particular, during inflation periods nominal interest rates, through their effect on the stream of real payments over time, very likely to have an effect on the ability of a segment of the population to buy a house.

While there is no clear cut way to model such factors, the earlier discussion does suggest that things like the initial payments to income and the faster buildup of equity are important features and may well affect the ability of individuals to buy houses.*

No study that we know of has reported attempts to measure the impact of such variables as the initial-payment-to-income ratio or some measure of the tilt of the stream of real mortgage payments. Of course, these effects presumably correlate somewhat with movements in things such as nominal interest rates, loan-to-value ratios, amortization periods and house prices. The following tables and discussion present in more detail implications from existing literature on the impact of some of these parameters of the mortgage instrument.

* If future incomes were known with certainty and if capital markets were perfect in the sense that individuals could borrow and lend at the mortgage rate, and, in particular, if they could borrow against future income, then there would be no problems with the level payment mortgage. Individuals could borrow on future income to finance their initial high mortgage payments.

A. Interest Rates

There is virtually unanimous agreement that increases in mortgage rates reduce demand for mortgages and the number of housing starts.

Table I shows mortgage interest rate elasticities of housing starts.*

A simple correlation between starts and mortgage rates might be an ambiguous sign. On the one hand, higher mortgage rates lower demand.

On the other hand, higher mortgage rates might increase the availability of mortgage credit and thus increase starts. For investigators who estimated demand and supply functions for starts, Table I reports only

demand elasticities. Other investigators have estimated some sort of reduced form relation. Their interest coefficients, while still negative on balance, are some mixture of demand and supply effects. On balance, the single equation elasticities estimates appear to be substantially lower than the demand equation elasticities. It should also be noted that some elasticities deal with a subset of total starts.

There are several channels through which mortgage rates might affect the demand for housing starts. One effect is through a change in the real mortgage rate, which would be expected to have a negative impact. Another effect is through the impact on monthly payments. Even if the real mortgage rate is unchanged, a higher nominal rate raises mortgage payments immediately and would be expected to reduce the demand for starts. A third effect might work through an expectations effect.

* Attempts to get elasticities for mortgage demand were less successful. Few authors reported elasticities; only Huang [36] published his data; measurement units were often ambiguous.

When the mortgage interest rate rises, individuals might postpone purchasing a house in the expectation of lower mortgage rates. To adequately model this effect would require some expression for expected future mortgage interest rates.

Few studies we have surveyed have made a systematic effort to sort out these various effects. Almost all of the studies have used simple nominal interest rates. Swan [80] mentions an unsuccessful attempt to measure the real mortgage rate. He speculates that the failure of the real rate to work properly is related to the question of the financing gap, but does not pursue the point with any measure of the gap. No other empirical study reports on any measure of a financing gap.* We conclude that while the existing literature overwhelmingly suggests the negative impact of increases in nominal mortgage rates on the demand for starts, it is impossible to disentangle that effect into its several components.

There are other points to be taken into account when assessing these interest rate elasticities. One is that most studies we have surveyed do not have explicit long run equilibrium properties. For example, imagine that the interest rate falls. One would expect the demand for housing and home building would increase. The higher level of home building will increase the stock of houses above what it otherwise would have been, if it exceeds depreciation. As the stock of houses

* It should also be mentioned that the precise measurement of a financing gap would involve other variables besides the mortgage rate. The size of the financing gap would be related to the size of the loan, the maturity of the loan and the rate of inflation.

approaches its new equilibrium one would expect the rate of home building to decline. Any permanent effect of lower interest rates on home building would work through the stock - depreciation of a larger stock - and through population growth - new families would demand larger houses in response to lower interest rates. The mechanism we have described in the familiar stock adjustment mechanism where the initial response of the flow to a change is larger than its long run response. As mentioned before, the studies we have surveyed have concentrated on the flow of starts. Little attention has been given to long-run properties, and most studies have looked at the number of starts rather than the quantity of home building (size or quality times number). When considering starts one would imagine that the long run equilibrium number of units in the housing stock is dominated by demographic factors. The long-run influence of income, prices and interest rates would have to work through effects on either household formation or the demand for second units.

There is also a simultaneous effect of changes in the price of housing services on net household formation or, at least, households occupying separate units. An increase in rents can cause two or more generations of unrelated individuals to share housing, the "doubling" phenomenon, even though this possibility is usually not very attractive.

If a higher level of income leads to more mobility and hence a higher turnover in the housing stock, one might observe a larger equilibrium level of vacant units and higher stock of houses. Similarly, the use of housing units on a seasonal or occasional basis does not affect the number of households, but does affect the number of available vacancies and the stock.

Other appropriate changes in basic demand factors may lead to a higher level of replacement investment and thus a higher level of starts for any constant stock.

A second thing to keep in mind when looking at the elasticity estimates is the problem of possible disequilibrium in housing markets. If, as many observers believe, credit rationing is, at times, a real constraint on home building, then some observations would not be expected to lie on the demand curve. Inclusion of those points in estimation could bias estimates of the elasticity upwards. Only if one somehow adjusted these data points for the amount of rationing is the bias eliminated.

Investigators have different views on the importance of rationing. Those who believe that rationing is important have included different variables in an attempt to measure credit rationing. (Two models with explicit allowance for rationing are Fair [23] and, following Fair, Swan [76]. Fair reports an interest rate elasticity of $-.59$ while Swan reports an interest rate elasticity of -1.92 . Fair used monthly data while Swan used quarterly data. There is also some difference in the data periods used for estimation.

A final thing to keep in mind, concerns one's view of what determines housing starts. Several models have an explicit structure of demand and supply equations for housing starts. An alternative view associated with Witte and Folev and Sidrauski investment models conceives of a demand for housing in general, new and old, that in conjunction with the existing stock, determines a price for housing. The number of housing starts is basically determined by builders as they compare the price people are willing to pay for housing with their costs.

On this capital asset pricing view, there is no separate demand for housing starts. A housing starts equation would emphasize the supply side and would include the price of houses. Alternatively one could eliminate the price of houses explicitly from the equation by including both the determinants of the stock demand as well as the stock itself.

The impact of credit rationing in such a model is usually seen as affecting the supply of starts as builders cannot get commitments.*

* Credit rationing might also affect the demand for the stock if individuals find it exceedingly difficult to obtain financing for units and thus lower the price they are willing to pay.

This view of investment also implies that most studies of housing starts have been misspecified. To talk of the demand for starts is clearly inconsistent with the capital asset pricing view. Particular starts equations might be better or worse approximations as they include good or bad proxies for the capital asset pricing model. The FMP model is the only one we have surveyed that is specified in the spirit of the capital asset pricing model.

V-OTHER MORTGAGE TERMS

Other mortgage terms, whose impact on the demand for housing and/or mortgage credit has been studied, are the loan-to-value ratio and the amortization period. The evidence of the impact of these terms is less extensive than that of interest rates. The absence of such terms from many models can be interpreted in several ways. Some investigators simply did not consider these variables either because of the lack of data, the belief they were correlated with other included variables, or the belief they were not important. Other investigators considered these variables during their preliminary work, did not get statistically significant results, and then eliminated the variables from their discussion. Still other investigators report on "unsuccessful" attempts to include such variables.*

With respect to the loan-to-value ratio, the existing estimates, as shown in Table II, suggest a very strong response of housing starts to the loan-to-value ratio. When the number of starts is the dependent variable, elasticity estimates range from 1.18 to 5.61**. The Lee [48] study which uses the value rather than the number of starts, finds a substantially lower elasticity. However, the Lee study is the only one that uses annual data. His data period runs from 1920-1941.

* By "unsuccessful" is meant a lack of statistical significance and/or an unexpected sign. This use of "unsuccessful" is a bit misleading. If a variable does not belong in an equation, the lack of statistical significance should not strictly be considered a failure.

** It should be noted that not all the elasticity estimates apply to total starts, some apply only to a subset.

All other studies use postwar quarterly data. If movements in the loan-to-value ratio are used to ration people out of the housing market in the short run, it would not be surprising to find a much larger response with quarterly data.

All the empirical estimates in Table II report a positive impact of the loan-to-value ratio on housing starts. Virtually all investigators have expected a positive impact although there are several possible ways that changes in the loan-to-value ratio could affect the demand for units. One can distinguish between a downpayment effect and a monthly payments effect. These two partial effects would be expected to work in opposite directions. The total impact of a change in loan-to-value ratios would thus be the sum of the two partial effects. The finding of a positive impact suggests the dominance of the down-payments effect.

Lower loan-to-value ratios mean higher downpayments and may thus eliminate families with little wealth from buying a house. Such an effect might mean no-house-purchase or the purchase of a smaller house. Such an effect might mean no-house-purchase or the purchase of a smaller house. The latter impact would not mean a reduction in starts, only a reduction in the average size of units started. Undoubtedly some combination of effects on both the number and size of units takes place for those families who are down payment constrained. This discussion also suggests that a more appropriate way to measure the impact of loan-to-value ratios would include some measure of the wealth of potential home buyers and the price of houses.

The other way changes in the loan-to-value ratio could affect starts is through its effect on monthly payments. Other things equal,

A - reported by author
 G - reported by W. Gibson in
 "Protecting Homebuilding
 from restrictive
 Conditions", BPEA, 1973:11

E - Estimated

TABLE I

The Effect of Nominal Interest Rates on Housing Starts

Investigator	Dependent Variable	Loan Parameter	Elasticity
MPS 1956:3-1972:2 Q	Value of Single family Starts	Mortgage Rate	$-.5^A$ (Long Run) -1.00^A (Short Run)
Brady 1960:3-197 :2 Q	Conventionally financed single family starts	Mortgage rate	-2.78^A
Brady 1960:3-197 :2 Q	All starts	Mortgage rate	-2.02^A
Arcelus-Meltzer 1915-40-48-68 A	All starts (demand)	Triple A corporate	-1.75^A
	Single family starts (demand)	"	-1.36^A
DRI (old) 1961:1-1973:2 Q	Starts	New corporate bond rate	$-.3^G$
Fair 1959:6-1969:12 Q	Starts (demand)	Mortgage rate	$-.59^G$
Huang 1953:2-1965:4 Q	Starts FHA (demand)	Mortgage rate	-2.36^E
Rosen 1962-4-1972:4 Q	Single family starts (demand)	Mortgage rate	-1.33^A
Kearl-Rosen 1962:4-1972:4 Q	All starts (demand)	"	-1.52^E
Maisel 1952-1965 Q	Starts	Mortgage rate	$-.56^A$
Swan 1958:1-1965:4 Q	Starts (demand)	"	-1.92^G
Smith Canada	Single family starts	"	-1.56^A
Bosworth-Duesenberry SA	Value of residential construction (\$1958)	Mortgage rate minus triple A corporate	-1.86^E
Marston 1953:3-1970:1 Q	Non-farm residential construction	Triple A	$-.67$

TABLE II

The Effect of Other Loan Parameters on Housing Starts

Investigator	Dependent Variable	Loan Parameter	Elasticity
Brady 1960:3 - 1970:2 Q	Conventionally financed single family starts	loan-to-value	2.54 ^A
" 1960:3 - 1970:2 Q	All starts	loan-to-value	4.6 ^A
Huang 1953:2 - 1965:4 Q	FHA starts (demand)	loan-to-value amortization	1.18 ^E .22 ^E
Rosen 1962:4 - 1972:4 Q	Single family starts (demand)	loan-to-value	5.61 ^A
Rosen-Kearl 1962:4 - 1972:4 Q	All starts (demand)	loan-to-value	2.37 ^E
Lee 1920 - 1941 A	Value of Starts	loan-to-value	.865 ^A
		mortgage rate times amortization period	-.277 ^A

A = reported by author

E = estimated

a higher loan-to-value ratio entails larger monthly payments. Larger monthly payments may eliminate some potential buyers.* This monthly payment effect suggests that higher loan-to-value ratios would reduce the amount of homebuilding. Again there could be effects on either the number of units, the size of units, or both. Only one study, Huang [35] has suggested a negative impact of loan-to-value ratios on housing activity. Huang uses a variable called per annum payment (loan-to-value ratio divided by the amortization period). He finds a negative relation between this per annum payment variable and VA housing starts. All other studies we have surveyed, and Huang's equations for FHA and conventionally financed starts, report a positive impact of increases in loan-to-value ratios on housing activity. We thus conclude that the down payment effect exceeds the monthly payments effect.

* In a world with perfect capital markets (see footnote, p 25) one would expect that for an individual both constraints of initial equity and monthly payments would be jointly binding or not binding. One would not expect that only one constraint would be binding. An individual with too much wealth and too little income could borrow against his future income and increase his initial equity. In fact, capital markets are not perfect. Thus some individuals may be constrained by their low initial wealth and other individuals may be constrained by their low income. However, there is a presumption that it is more difficult to convert future income into current wealth than it is to convert current wealth into future income. Such a presumption suggests that the equity constraint may be the more important empirical phenomenon. This expectation is also consistent with the observed positive impact of increase in the loan-to-value ratio on housing activity.

As with the mortgage rate, the interpretation of the empirical results on loan-to-value ratios needs to recognize the lack of an explicit long-run equilibrium model. The implications of possible disequilibrium in housing markets may not be as serious for interpreting coefficients on the loan-to-value ratio. Some investigators have argued that the loan-to-value ratio is, in fact, one measure of possible disequilibrium. Finally if the capital asset pricing view is correct, many starts equations may have been seriously misspecified.

To briefly conclude the discussion of the loan-to-value ratio, we find suggestive evidence of a substantial impact of the loan-to-value ratio on housing starts.

Evidence on the impact of amortization periods on housing starts is more sparse than that for the loan-to-value ratio. Huang finds a small positive elasticity while Lee finds a small negative elasticity. However, Lee enters the amortization period multiplicatively with the mortgage rate, which makes the interpretation of his coefficient quite difficult.* We conclude that in the existing literature there is some suggestion of a small positive impact on housing starts of lengthening the amortization period.

* Unfortunately his specification does not include the mortgage rate as a separate variable. If it had, interpretation of this variable would be possible.

With regard to the demand for mortgage credit, there is more limited evidence of a positive impact of both the loan-to-value ratio and the amortization period. Clauretie found large, positive and significant coefficients for both variables. Huang is the only other investigator to find any impacts of the non-rate terms on the demand for mortgage credit. His earlier work [36] finds a positive effect of changes in the amortization period. His later work [35] has the peculiar variable measuring per annum payments. Those results indicate that increases in the loan-to-value ratio decrease the demand for mortgage credit. Huang's use of the per annum payment variable necessarily implies that the loan-to-value ratio and the amortization period will have effects of opposite sign.

In the interpretation of this evidence one should distinguish between the indirect effect of non-rate terms on mortgage demand through their effect on starts and any additional direct effect on the demand for mortgage credit. In the Clauretie study, the non-rate terms have to be measuring both effects. However, other questions about the specification of his equation suggest caution in interpreting his results (see page 16). In Huang's earlier study the change in the amortization period is also capturing both effects while in his later study the per annum payments variable is measuring only any additional effect. The equation already includes the value of new starts which in turn are influenced by both non-rate terms. We conclude that the existing literature offers only a limited suggestion of a direct effect of non-rate terms on the demand for mortgages. The largest effect would have to be derived from any impact on housing activity.

VI - A COMPARISON OF MODEL STRUCTURES

We have provided schematics for overall comparison of model structures and included/excluded variables. The models are reported as estimated. Those empirical studies examining starts are outlined in Chart I. Those examining value of starts are in Chart II. Those examining mortgage demand functions, most normalized on the mortgage rate, are in Chart III.

[illegible]

DEP
VARIABLE

H1

H0

H

H

SLIND

SLIND

REPORTAGE
OTHER
 $\delta(x_1, x_2, x_3, x_4, x_5)$

$r_{m..}$
 $r_{m..} \Delta r_m$
 $r_{m..} \Delta r_m$

SAVINGS

SAV

SAV₁

VARIACT-1
L.P.
FILL

1

1

1-3

FILL₂

VACANCY
OMTEP

1

VAC₁

[illegible]

DEB VARIABLE	r_{n-1}	r_n	FORMER	r_{n-1}^{1st}	DEPOSITS	MORTGAGE STOCK	HOUSING STOCK	HOUSING STAKES	LOAN/ VALUE	AMORTIZATION PERIOD	INCOME	RENTAL	P ^{HOUSING}	VACANCY	DEMOGRAPHIC	COMMENTS
BOULWORTH- DUESENBERY	Δr_n				% ΔSAW	% ΔMS_n	% ΔMS_n									$SAW = .75 DSL + .15 DJP + .15 DGB + .15 TRU$
CLAIRETIE	M	r_n							LVR	AMORT YR	K/PH	DEM				
DRI	r_n	r_n	r_{n-1}	r_{n-1}		$M/(HV + MS_n)$	$MS_n/(HW + HS_n)$									
HUANG	M				$\Delta MS_n/A$	H	LVR/AMORT									
JAFFE (NYS)	r_n	r_n	r_{n-1}	r_{n-1}		$(\Delta MS_n + MS_n)/(HV + HS)$										$(OCSL_n + OCSB_n + OCSLL_n)/(HV + HS)$
KEARL- KODEN	M	$(r_n - r_{n-1})..$				H										
SILBER	ΔMS_n	Δr_n			ΔMS_n						ΔY	ΔHH				
CASSIDY- VALENTINE	r_n	$X \{ r_n - r_{n-1} + (r_n - r_{n-1}) \}$			MS	HS_n					Y^p					

A	Total financial assets
AMONT	Amortization period
C	Construction costs
D	Deposits in various thrift institutions
DUM	Dummy variables
FHLB	FHLB advances
FNMA	FNMA mortgage acquisitions
H	Housing starts
HMF	Household formation
HS	Stock of housing
LVR	Loan value ratio
M	Mortgage flows
P	Price of other goods
PH	Price of housing
PI	Price, Housing investment
PI ^e	Expected inflation rate of housing prices
POP	Population variable
R	Rent index
r _{AAA}	AAA bond rate
r _{CP}	Commercial paper rate
r _M	Mortgage interest rate
r _{TB}	Treasury bill rate
SAV	Saving flows
STRG	Monetary stringency variable
SUB	Subsidized starts
S/P, B/P	Monetary base
T	Time
U	Unemployment
VAC	Vacancy rates
W	Wage
Wt.	Wealth
y ^D	Disposable income
y ^P	Permanent income

Superscripts:

D	Demand
S	Supply
VA, FHA, C	Mortgage types

Subscripts:

-i, ith	Lagged value
m, aaa, cp, etc.	Interest rate type

1. Alberts, W.W. "Business Cycles, Residential Construction Cycles, and The Mortgage Market," JPE, 1962, pp.263-281.

Housing cycles are not due to fixed rates on FHA VA mortgages, but primarily because of other factors which change the supply of mortgage funds.

As aggregate demand in the economy falls, housing demand falls little, and permanent income may not have changed much. Therefore, housing demand has changed little relative to changes in the supply of mortgage funds. The supply of mortgage funds shifts because of changes in the relative yields of bonds and mortgages over the business and construction cycle.

No reported estimations.

2. Arcelus, F. and A.H. Meltzer, "The Markets for Housing and Housing Services," Journal of Money, Credit and Banking, 1973, pp.78-99.

A flow of services is generated from a given fixed stock. Demand for the services determines the rental price per unit of services. The supply of additions to the stock is determined by builders comparing the prices of new units with costs. Arcelus-Meltzer then assume a separate demand for new units as a function of the price of those units, income, wealth, interest rates, equity, rental rates and the expected expenditures for services generated by the stock relationship. A log-linear annual model is estimated over the 1915-60, 1948-68 period.

Estimations indicate that the demand for services is significantly affected by the rental price, real income, prices and the real value of assets. The authors use the real mortgage stock and changes in the stock as measures of the importance of credit availability and loan-to-value ratios in housing demand. They find a high interest elasticity but no evidence that mortgage availability is important.

The authors conclude there is no relationship between the stock or flow of mortgage credit and the demand for housing. The interest rate not the composition of credit is important.

3. Atkinson, L.J., "Long-term Influences Affecting the Volume of New Housing Units," Survey of Current Business, 1963:11, pp. 8-19

Extensive treatment of the relationship between general demographic characteristics of the nation and household formation. The author, very much in the spirit of Maisel's work, links household formations to housing starts.

4. Atkinson, L.J., "Factors in the Housing Market," Survey of Current Business, 1960:4, pp. 16-22.

Article examines demographic, income and short-run financial impacts on housing.

5. Bosworth, B. and J.S. Duesenberry, "A Flow of Funds Model and Its Implications," Issues in Federal Debt Management, Boston, MA: Federal Reserve Bank of Boston, 1973, pp. 39-149.

The long run demand for mortgage funds is assumed dependent upon the demand for the underlying capital, housing units, and by portfolio choices. New building contributes to mortgage demand directly and indirectly through its effect on refinancing of old units. It is argued that most of the fluctuations in home building result from fluctuations in the supply of mortgage funds. Since builders expand activities when vacancies are low and contract when vacancies are high, vacancies serve as a measure of short run demand for mortgage. A disequilibrium model is proposed where lenders adjust rates but not enough to clear the market, this change also affected by competing yields and savings flows. Lenders lend consistent with their supply curve.

The model specifies an equation for the percentage change in the stock of mortgages which is assumed to depend on vacancy rates, mortgage and other market interest rates and a time trend. The equation is not estimated directly but is substituted into an equation representing the adjustment of mortgage rates.

The residential construction function simply translates changes in the mortgage stock to expenditures.

Changes in the real mortgage stock, changes in household formation, changes in the spread between mortgage and corporate bond rates, and a trend are found to be important determinants of residential construction.

6. Brady, E.A., "An Econometric Analysis of the U.S. Residential Housing Market," In National Housing Models, R.B. Ricks, ed., Lexington, MA: Lexington Books, 1973.
7. Brady, E.A., "A Sectoral Econometric Study of the Post-War Residential-Housing Market," Journal of Political Economy, 1967, pp. 147-158.
8. Brady, E.A., "A Sectoral Econometric Study of the Post-War Residential-Housing Market: Reviv," Journal of Political Economy, 1970, pp. 274-278.

Brady discussed an underlying structural model but no rigorous derivation of estimated reduced forms is presented. Reduced form estimation of housing starts functions disaggregated by type of financing, FHA, VA, or conventional are examined. Variables are selected for the various functions by explorations leading to the best fit.

In the 1967 work, he hypothesizes that fixed interest ceilings on FHA and VA instruments have contributed to housing cycles. Estimation over the 1952-1963 period by OLS finds loan-to-value ratios, amortization period length, FNMA acquisitions, a trend and a measure of monetary stringence important determinant of starts.

Brady argues that government and conventional financed sectors of the housing market behave differently due to rigidity of government insured mortgage rates.

The 1971 work, a variety of dependent variables are regressed on the same variables as the 1967 work with the addition of construction costs and FHLB advances. The cost variable has the wrong sign, however.

Brady finds interest elasticities in the 1.0 to 2.8 range and loan-to-value elasticities from 2.5 to 4.6. FHLB advances are also important. He argues that conventionally financed and federally guaranteed or insured markets differ a great deal, and conclude that the major short run determinants of cycles are from the supply side of the market.

Brookings Quarterly Econometric Model of the United States

See S. J. Maisel

10. Burns, Arthur F., "Long Cycles in Residential Construction," in Business Fluctuations, Growth, and Economic Stabilization, Clark and Cohen (eds.), 1963.

Long cycles derive from the variability of population, durability of dwelling, and immobility of dwellings and men.

"Cyclical fluctuations shake out the inefficient so actually may benefit construction industry."

An interesting qualitative article speculating on the causes of the long cycle in construction.

No mention made of impact of financial variables on long cycles of construction.

1. Campbell, B.O., "Long Swings in Residential Construction: The Post-War Experience," AER Papers and Proceedings, 1963.

Long swings are essentially demographic in nature, size and age composition of population are crucial. Mentions impact of federal mortgage insurance programs in contribution to upward shift in single family demand during the post-war period. Explains discrepancy between starts and household formation on varying headship rates.

No model, or equations, concerned with non-financial determinants of demand. Ignores financial factors when attempting to explain deviation from expected starts from household formations.

1. Cassidy, H.J. and J. Valentini, "A Quarterly Econometric Model of the U.S. Housing, Mortgage, and Deposit Markets," unpublished paper presented at the 1972 Winter Meetings of the American Real Estate and Urban Economics Association.

Households demand for housing services is determined by the implicit rental (which differs for owner-occupied and rental units and influences the rent-buy decision) and permanent income. Comparing this demand with the stock of housing determines vacancies. The authors postulate a demand for new units based on the excess demand for the stock, mortgage interest rate and change in mortgage rate. Supply of starts, normalized on prices, is determined by unemployment, wage rate and prices in the construction industry.

The Cassidy-Valentini model emphasizes a stock demand for mortgages. The demand for the stock of mortgages depends on the mortgage rate, the nominal value of the housing stock and permanent income. The equation is estimated by normalizing on the mortgage rate and allowing for possible disequilibrium by including positive changes in the mortgage rate.

Claurette, T.M., "Interest Rates, the Business Demand for Funds, and the Residential Mortgage Market: A Sectoral Econometric Study," Journal of Finance, December 1973, pp. 1313-1326.

Claurette attempts to test the degree to which business demand for funds affect the supply of mortgages in ways not wholly reflected by the interest rate.

Claurette presents a mortgage market model where the demand for mortgages is assumed to depend on permanent income, the ratio of rent to home ownership costs, the loan-to-value ratio, the average maturity of mortgage contracts, the number of people aged 25-34 and the mortgage rate. Numerous regressions are run with both net and gross changes in mortgages as the dependent variable. The maturity measure and loan-to-value rate always have a positive impact on the demand for mortgage.

Data Resources Model

The DRI model specifies the demand for mortgages in terms of an equation for the mortgage rate. Variables entering the equation include current and lagged corporate bond yields, the percentage change in FNMA plus GNMA mortgage holdings, a weighted average of deposit rates at savings and loan associations and mutual savings banks, and two variables that are the ratio of mortgage acquisitions and the stock of mortgages to residential construction plus a measure of capital gains on the existing stock.

The DRI model is estimated on quarterly data availability for the particular function. A starts equation is estimated, which essentially links starts plus mobile homes to real mortgage flows, real interest rates, and vacancy rates. Relationships, vacancy rates, mobile home shipments, implicit price deflator, mortgage yield and mortgage flows are also estimated.

The stock is an important determinant of vacancy rates along with household assets, population and unemployment rates. The price equation depends upon variables outside of the housing sector: employee compensation, price of gross product, and a production index. The mortgage rate is functionally related to bond yields, housing stocks, consumption expenditures on housing and mobile homes, mortgage acquisitions and thrift institution deposit rates.

FNMA and GNMA acquisitions enter the mortgage yield equation separately from mortgage acquisitions by other financial intermediaries.

No price or cost variable appear in the starts function.

- 15 Dhrymes, PJ and Taubman, PJ, "An Empirical Analysis of the Savings and Loan Industry" in I Friend, ed., Study of the Savings and Loan Industry, Washington, DC: Federal Home Loan Bank Board, 1969, pp. 67-182.

Dhrymes and Taubman use data from a time series of cross sections of S&L's for 1964-1966. Their data is then aggregated to SMSA averages. They relate the demand for all new mortgages at S&L's to normal income per capita, the amount of building activity is measured by the value of permits, the mortgage rate, the loan to value ratio, the lagged stock of mortgages and the amount of repayments. Equations are estimated for western (California) and non-western associations and including and excluding 1966. Dhrymes and Taubman consider the results for western associations unreliable. Results for non-western associations appear to be quite sensitive to the inclusion or exclusion of 1966 as well as the use of a generalized least squares procedure designed to reduce some cross section biases.

16. Duesenberry, JS and Kistin, H, "The Role of Demand in Economic Structure," in W. Leontief et al, Studies in the Structure of the American Economy, NY Oxford U. Press. 1953.

The authors found an extremely low (.078) demand elasticity with respect to price, real income constant.



17. deLeeuw, F. "The Demand for Housing: A Review of Cross-Section Experience," Real Estate Statistics, 1971

Reviews the work of Muth, Reid, Lee and Winger, and concludes that the income elasticity is between .8 - 1.0. It tends to be higher for owner occupied than for rental housing, lower for non-whites and increases with household size.

Using data from the 1960 Census, deLeeuw estimates renter income elasticities between .8 and 1.0 and relative price elasticities for renters in the .7 - 1.5 range.

3. deLeeuw, F. and N. Ekanem, "Income and the Cost of Rental Housing," Working Paper 112:11, Urban Institute 1970.

Using data from a 1967 cross section and imposing demand elasticities from earlier studies, the authors find elasticities of supply with respect to per unit service (rental) between .3 - .7, with respect to cost of capital inputs between -.5 to -.2, with respect to operating inputs in the -.3 to -.1, range and with respect to the number of households about 1.0.

- deLeeuw, F. and N. Ekanem "Time Lags in the Rental Housing Market," Working Paper 112:19, Urban Institute 1970.

Using demand and supply elasticities from earlier studies, this study investigates the dynamics of adjustment of the rental market. The authors conclude that the annual speed of adjustment for demand response to income and price change is .25, for rent response to utilization of stock is .40, for rent response to costs is .10, and the supply response to profitability is, with some uncertainty, in the .30 region.

2. deLeeuw, F. and E.M. Gramlich, "The Channels of Monetary Policy," Federal Reserve Bulletin, June 1969, pp. 472-491

21. Evans, M.K. Macroeconomic Activity, New York: Harper & Row, Publishers, 1969.

Quarterly model using value of residential investment is estimated. Evans argues that a good measure of credit tightness is the spread between short term and long term rates. The principal determinant of long run housing demand is household formation. Income is not viewed as an important long run determinant nor are credit conditions, but these variables do affect short run behavior: income affecting the value per start, interest spreads as a measure of the residual nature of housing finance. Cycles are primarily a supply phenomenon, resulting from the residual credit and labor that is available to builders.

2. Fair, R.C. "Disequilibrium in Housing Models", Journal of Finance, 1972, pp.207-221.
3. Fair, R.C. "Monthly Housing Starts", in National Housing Models, R.B. Ricks, ed., Lexington, Mass: Lexington books, 1973, pp.69-84.
4. Fair, R.C. A Short-run Forecasting Model of the United States, Chapter 8, Lexington, Mass: Lexington Books.

Fair develops a monthly structural model of housing starts. Only looks at the market for new houses and mortgages. Uses a disequilibrium model in the sense that either on the demand or supply (of funds) schedule, where the direction of interest rate movements indicates which. Assumes that changes in the loan value ratio are reflected by a secular trend (i.e. no cyclical fluctuations). Theoretically specifies three sectors, demand for mortgages (and assumes is equivalent to demand for new houses), supply of mortgage funds, and supply of houses by builders. In estimation eliminates the latter.

The demand for housing starts is a function of time (population plus income), stock of houses and houses under construction, mortgage interest rate lagged two months, and seasonal factors. The supply of funds is a function of deposit flows into thrift institutions, advances of FHLB, seasonal factors, and the mortgage rate lagged one month.

The model is estimated on monthly data, from 1959:6 to 1969:11, using the 2SLS disequilibrium technique described by Fair and Jaffee (Econometrica, 1972).

25. Federal Reserve Staff Study: Ways to Moderate Fluctuations in Housing Construction; Board of Governors of Federal Reserve System, December 1972

26. Flow of Funds Model (See Bosworth and Duesenberry)

27. Frigg, J., Study of Savings and Loan Industry, FHLBB, Washington, July 1969, 4 volumes

28. Geisel, M., "A Survey of Time Series and Cross-Section Studies of Housing," unpublished paper, Carnegie-Mellon University, 1971.

Geisel suggests, in support of deLeeuw, that income elasticity is approximately one.

29. Greber, Leo, "Housing Issues in Economic Stabilization," NBER Occasional Paper, 72, 1960.

"Given long-run demand and supply forces favorable to residential building, short run cycles in housing construction were associated for the most part with changes in the supply of mortgage funds and credit terms, which in turn were greatly influenced by the level of total economic activity. When that level was rising and high, the expanded demand for funds by business, which is relatively insensitive to increased cost of borrowing tended to reduce the availability of funds for housing, which is highly sensitive to changes in cost of borrowing."

FHA-VA fixed rates contribute to housing cycles.

30. Grebler, Leo, "Stabilizing Residential Construction - A Review of the Postwar Test," American Economic Review, 1949.

Emphasizes role of liberalized credit terms, downpayment, interest rates, and amortization period in creating housing boom.

Mentions that effects of liberal credit stimulating demand may lead to price increases which wipe out much of the expected gain from liberal credit.

The post-war period saw large price increases.

31. Grebler, L. and S. Moisel. "Determinants of Residential Construction: A Review of Present Knowledge." Impacts of Monetary Policy, Commission on Money and Credit, (Prentice-Hall, Englewood Cliffs, N.J.), 1963

32. Grebler, L., Blank, D.M., Winnick, L. Capital Formation in Residential Real Estate (Princeton U. Press, 1956).

Found a marked retardation in the rate of growth of residential construction and in the real capital investment per new dwelling unit despite changing financial positions and increasing real income over the 1890-1950 period. Claimed to show a 15% decline in the average value of a unit of stock, a 36% decline in the average values of new units while the stock climbed only 7% in value.

3. Guttentag, J. "The Short Cycle in Residential Construction, 1946-59." AER, 1961, pp.275-98.

Emphasizes the central role of mortgage credit in the short cycle in residential construction. This qualitative analysis examines the relations between construction and mortgage yields, mortgage terms and Federal influences in the market.

Since other demand factors do not change much in the short run, i.e. income, demographic, and relative prices, availability and price of credit is perceived as crucial in explaining short run cycles.

He argues "the volume of mortgage credit is a sort of residual, in that home buyers can obtain only that volume of credit which remains after more volatile and persistent demands of corporations have been satisfied." He also suggests that the importance of FIA-VA ceilings in determining mortgage flow have been over emphasized. Finally he suggests that FNMA has tended to mitigate cycles due to its sticky mortgage purchase prices.

34. Housing and Monetary Policy Conference Series No. 4, The Federal Reserve Bank of Boston, October 1970.

35. Huang, D.S. "Effects of Different Credit Policies on Housing Demand," Study of the Savings and Loan Industry, Vol. III, I. Friend, ed., Washington: Federal Home Loan Bank Board, 1969.

Develops a supply-demand structural model of both the mortgage and housing markets. Disaggregates by three sectors: FHA, VA, and conventional sector. "It is well recognized in the financial market that the supply of mortgage credit has a controlling influence over housing starts, and it may be said that the direction of causation here is generally accepted as from mortgage credit supply to housing starts."

Estimates demand and supply for starts in terms of units and dollar value for the three sectors. Also estimates the demand for and supply of mortgage funds.

He estimates his model by OLS on quarterly data from 1953:2 to 1965:4. A number of financial variables, such as interest rates, loan-to-value ratio, interest rate ceilings, and savings flows are used, although he selects the actual variable in each function by experimentation.

Huang finds that loan-to-value ratios are consistently important determinants of flow demand of new housing units. Average maturity lengths were not found significant nor percentage of loan paid per year except for VA guaranteed homes. Mortgage interest rates were found to be not significant but household formation and a debt term were significant.

FNMA and FHLB were important in appropriate supply functions and yields and yield spreads are predominant in influencing mortgage flows.

The demand for mortgages (gross borrowings) is assumed to derive from the value of housing starts, the change in the ratio of mortgage debt to total financial assets and the "proportion of mortgage loans payable per annum" (loan-to-value ratio divided by the maturity).

Equations are estimated by the type of mortgage - FHA, VA, conventional. The value of starts has a positive effect while the ratio of mortgage debt to financial assets and the proportion variable both have negative effects.

36. Huang, D.S., "The Short-Run Flows of Non-farm Residential Mortgage Credit," Econometrics, 34, (April 1966), pp. 433-459.

Huang concentrates on mortgages for single-family units. The model related the demand for mortgages to the desired level of owner-occupied housing - represented by income and the ratio of rents to construction costs - the nominal mortgage rate and the change in the amortization period. The change in the amortization period is assumed to reflect non-interest rate credit terms and to correct the measure of the mortgage rate which is a measure of mortgage yield assuming fixed maturity and prepayment. The change in the amortization period is estimated to have a positive impact on the demand for mortgages.

37. Huang, D.S. and M.D. McCarthy, "Simulation of the Home Mortgage Market in the Late Sixties," Review of Economics and Statistics, 69 (November 1967), pp. 441-450.

Simulations with a model very similar to Huang's "Short Run Flows" model; demand for mortgages are now disaggregated by type of financing - conventional, FHA, VA.

38. Jaffee, D.M., "An Econometric Model of the Mortgage Market: Estimation and Simulation," Chapter 5, in Savings Deposits, Mortgages and Residential Construction, Gramlich and Jaffee (eds), Lexington: Heath-Lexington, 1972.

The demand for the stock mortgages is assumed to depend on the value of the housing stock, the mortgage rate and a corporate bond rate as a single proxy for other market rates. Jaffee notes that mortgage funds may be used for other purposes than purchasing a house. He also notes that other non-rate terms of the contract should, in principle, affect the demand for mortgages. Differential time responses are allowed for the mortgage demand arising from new construction and the existing stock. Jaffee's equation is estimated implicitly following substitution into a mortgage rate adjustment equation.

39. Kalchbrenner, J.H. "A Model of the Housing Sector," in Savings Deposits, Mortgages and Housing, E.M. Gramlich and D.M. Jaffee, eds. Lexington, Mass: Lexington Books, 1972.
40. Kalchbrenner, J.H. "A Summary of the Current Financial Intermediary, Mortgage and Housing Sectors of the FRB-MIT-Penn Econometric Model," in National Housing Models, R.B. Ricks, ed. Lexington, Mass: Lexington Books, 1973.
41. Kalchbrenner, J.H. "Theoretical and Empirical Specifications of the Housing Sector," in Ways to Moderate Fluctuations in Housing Construction, Washington: Federal Reserve Board of Governors, 1972.

The supply of housing services is assumed proportional to the housing stock. Given the stock, the demand for housing services, a function of permanent income and relative prices determines an implicit rental. This rental, together with a housing cost of capital, determines the asset prices of the stock. Builders compare their costs with the asset price and this yields additions to the stock in the form of residential investment. This addition to the stock drives down the asset price and consequently net investment falls. In equilibrium, the housing stock, the housing price, the cost of capital and construction costs adjust to steady-state values.

Given the stock, the demand for services function is rewritten in terms of the implicit rental. Since, in equilibrium, this rental relative to the price of the stock equals the cost of capital, the rental can be eliminated by substitution. An empirically workable reduced form is obtained by substituting for the asset price of the stock the appropriate relationship from the supply side.

The model is estimated quarterly from 1954:4 to 1969:3 in log linear form by OLS. Separate functions are estimated for single family plus mobile homes and multifamily, basically as outlined above except for the addition of variable to account for rationing in the mortgage market. The permanent income elasticity is constructed to unity.

The model also estimates relationships for total housing expenditures and the stock. The cost of capital relationship for single family units is created by assumption about depreciation and opportunity costs. No cost of capital appears in the multifamily relationship.

The cost of capital is used only in the single family function and failed to have appropriate sign in the multifamily function as it has been omitted from that specification. Rationing is handled in a rather ad hoc manner.

43. Kalchbrenner, J.H., "A Summary of the Current Financial Intermediary, Mortgage and Housing Sectors of the FRB-VIT-Penn Econometric Model," In National Housing Models, R.B. Ricks (ed), Lexington: Lexington Books, 1973

(See D.M. Jaffee).

44. Kearl, J.R. and K.T. Rosen. "A Model of Housing Starts, Mortgage Flows, and the Behavior of the Federal Home Loan Bank Board and the Federal National Mortgage Association," Working Paper #27, Joint Center for Urban Studies, May 1974.

A six equation quarterly simultaneous model is specified and estimated: demand and supply for starts, demand and supply of mortgages and reaction functions for FHLBB and FNMA.

Demand for starts is found to be strongly related to the relative price of housing, mortgage interest rates, the loan-to-value ratio, and subsidies. Supply of starts is determined by vacancy rates, prices, construction loan rates and mortgage commitments.

The demand for mortgages depends on housing starts and the spread between the mortgage rate and the corporate bond rate.

The authors use three stage least squares over the 1962:4-1972:4 time period.

The research is primarily concerned with the structure of FNMA and FHLBB and their interactions with the mortgage and housing markets. Both FNMA and FHLBB are found to have strong positive impacts on mortgage flows even though they do not always behave in an appropriate counter-cyclical manner.

44. Klamman, S.B., "Effects of Credit and Monetary Policy on Real Estate Markets," Journal of Land Economics, August 1956, pp. 239-249.
45. Klamman, S.B., "The availability of Residential Mortgage Credit," in Committee on Banking Currency, Subcommittee on Housing, U.S. Senate, Study of Mortgage Credit, Washington. GPO, 1958.

Interest ceilings on FHA and VA mortgages have intensified the impacts of monetary policy on the housing sector, and are the primary cause of housing cycles.

46. Klamon, S., The Post War Residential Mortgage Market. Princeton University Press, 1961

47. Klein, L.R. "A Postwar Quarterly Model: Description and Applications," Studies in Income and Wealth, XXVIII, 1964.

48. Lee, T.H. "The Stock Demand Elasticities of Non-Farm Housing," Real Estate Statistics, 1964, pp. 82-89.

Annual model of housing, 1920-41, using OLS on value of construction per family. Lee argues that Muth's income elasticity is biased upward by omission of credit terms. Concludes that income elasticity less than unity, price elasticity exceeds unity and demand is strongly related to mortgage costs and down payments.

Price elasticity is near one (-1.07) but the income elasticity is quite low (.336). Elasticities for loan-to-value variables (.865) and interest times mortgage length (-.277) are estimated.

49. Lee, T.H. "Demand for Housing: A Cross Section Analysis," Real Estate Statistics, 1965, pp. 190-196.

Cross section probability study. Concludes that current income does not appear important determinant of probability of buying a home. However, age is an important factor in accounting for price and probability of incurring mortgage debt.

50. Liu, T.C. "An Exploratory Quarterly Econometric Model of Effective Demand in the Postwar U.S. Economy," Econometrica, 1963, pp.301-48.

A quarterly model is estimated over the 1947:3-1959:4 period. Both OLS and TSLS techniques are used, although simulations are conducted with the OLS estimates. Housing investment is modeled within a very simple investment structure, and is functionally related to corporate bench rates and money supply variables.

51. Maisel, S.J. "The Effects of Monetary Policy on Expenditures in Specific Sectors of the Economy," Journal of Political Economy, 1968, pp.796-814.
52. Maisel, S.J. "Non-business Construction," in The Brookings Quarterly Econometric Model of the United States, J.S. Duesenberry et al, eds., Chicago: Rand McNally & Co., 1965.
53. Maisel, S.J. "A Theory of Fluctuations in Residential Construction Starts," American Economic Review, 1963, pp.359-383.

Maisel views cyclical behavior in housing as analogous to inventory cycles. There is an underlying demand, a function of household formation and removals from the housing stock, which form a relatively stable equilibrium. Forces imbedded in the construction process create fluctuations in vacancies and inventories which cause cycles in starts around the underlying basic demand equilibrium. Starts are influenced by credit through inventories and vacancies rather than through final demand or through changes in household formation.

A quarterly model is estimated over the 1950-60 time period by OLS. Later articles extend the estimation period to 1962, then from 1953:2-1967:2. In the Brookings work functions for household formation expenditures and average cost per unit are estimated. Relationships are postulated for removals and vacancy deviations.

In the most recent article, Maisel includes in five separate regressions credit variables including mortgage interest rates, savings flows and FNMA purchases. He concludes that, at the the interest elasticity is .56 and credit availability elasticity is .07.

54. Maisel, S., Burnham J and Austin, "The Demand for Housing: Comment," Real Estate Statistics, 1971.

Using data on a cross section, the authors found that grouping observations biased the income elasticity upward by 50%. They argue that the elasticity is consequently closer to .62 (near Less's .7) than 1.0.

55. Mattila, J.M. "An Econometric Analysis of Construction," Wisconsin Commerce Reports, April 1955.

A study of the value of starts from 1920-41. Found that a composite credit term, mortgage interest divided by the product of the loan-to-value ratio and the amortization period was not a significant determinant of the housing demand.

56. McCarthy, M.D. The Wharton Quarterly Econometric Forecasting Model, Mark III, Studies in Quantitative Economics No. 6, Wharton School of Finance and Commerce, 1972.

The present model follows very much M.D. Evans approach to modeling housing. A value of residential investment is estimated. The sector is completed by estimated relationships of depreciation and price deflator for residential investment and definitional relationships.

57. McElhone, J.M. and H.J. Cassidy, "A Call for Innovation," Federal Home Loan Bank Board Journal, July 1974.

58. Meltzer, A.H. "Credit Availability and Economic Decisions: Some Evidence from the Mortgage and Housing Market," Journal of Finance, June 1974, pp.

Long term data show that housing stocks have grown at approximately the same rate as other assets and much less than mortgage credit. The ratio of housing to total assets remained unchanged over a period in which the availability of mortgage credit rose rapidly. Meltzer argues that there is no empirical evidence that availability of mortgage funds matters in the housing market.

59. Modigliani, F.M., "Some Economic Implications of the Indexing of Financial Assets with Special Reference to Mortgages," Sloan School Working Paper #736-74, MIT, September 1974
60. MPS Model
(See J.H. Kalchbrenner)
61. Muth, R.F. "The Demand for Non-farm Housing," in The Demand for Durable Goods, A.C. Harberger, ed., Chicago: The U. of Chicago Press, 1960.
62. Reid, M.G. "Capital Formation in Residential Real Estate," JPE, 1958, pp.131-153.
- In a review of Grebler, Blank, Winnick, Capital Formation..... Reid argues that there has been an upward trend in quality and over the period, 1920-1929. She found high high elasticities of both income (1.78-2.30) and price (.91-2.45). In a 1950 section respective elasticities are estimated to be 2.03 and 1.61.
63. Schaef, A., "Federal Mortgage Interest Rate Policy and the Supply of FHA and VA Credit," Review of Economics and Statistics, November 1958 pp. 284-289.
- Housing cycles result primarily from the structure of fixed rates.
64. Silber, W.L., "An Econometric Model of the Mortgage Market," in Cyclical and Growth Problems Facing the Savings and Loan Industry, A.W. Saratz (ed.) Bulletin No. 46-47, Institute of Finance, N.Y.U., 1968.

The demand for the stock of mortgages is related conceptually to the desired stock of houses, the nominal mortgage rate, the loan to value ratio and the amortization period. All variables, including the determinants of the desired stock of houses, are assumed to enter linearly. The final estimated equation drops all variables except income and the mortgage rate. The lagged mortgage stock is also included to represent a stock adjustment mechanism.

65. Silber, W.L., Portfolio Behavior of Financial Institutions, New York: Holt, Rinehart and Winston, 1970.

There is an elaborate discussion and estimation of the demand for mortgages by financial institutions. There is no discussion or estimation of the demand for mortgage credit (supply of mortgage liabilities).

66. Smith, L.B. "A Bi-Sectoral Housing Market Model," Canadian Journal of Economics, 1969, pp.557-569.
67. Smith, L.B. "A Model of the Canadian Housing and Mortgage Markets," Journal of Political Economy, 1969, pp.795-816.
68. Smith, L.B. Housing and Mortgage Markets in Canada, Bank of Canada, 1970.

Develops a model of the Canadian housing and mortgage market, which specifically recognizes both the segmentation and linkages between the two markets within a stock flow framework.

States that "credit variables have a strong influence on the demand for housing, since, for most families this demand is quite sensitive to downpayment and monthly payment requirements; and these payments depend upon the nominal purchase price, the mortgage interest rate, the loan-to-value ratio and the amortization term of the mortgage." He believes that credit terms have a stronger impact on the quality of housing services demanded, than on number of units demanded.

Estimates reduced form equations for investment in residential construction, total housing starts, price of housing, total stock of housing units, construction costs, land costs, and conventional mortgage interest rates. He uses both OLS and 2SLS techniques on quarterly data for the period from 1954-1967.

The two credit variables, mortgage interest rate, and a variable to proxy availability of mortgage funds (spread between the mortgage interest rate and other market rates), are significant and have the correct sign. He finds an interest elasticity for S^r starts of -1.56.

69. Smith, L.B. "A Sectoral Econometric Study of the Postwar Residential Housing Market: An Opposite View," Journal of Political Economy, 1970, pp.268-273.

Smith examines two models: a Muth-type long run stock demand for housing and a short run supply model. Using these models and Canadian data, he suggests that the dramatically different behavior of conventional and government backed mortgaged housing starts found by Brady is not supported with his data. Smith argues that the two sectors do respond to the same economic variables and in similar ways.

He estimates starts equations with and without lagged stock. Both models show strong relationships between starts and interest rates and mortgage flows.

70. Smith, W.L. Staff Report on Employment, Growth and Price Levels, Joint Economic Committee, Washington: GPO, 1956.
71. Smith, W.L. "The Impact of Monetary Policy on Residential Construction, 1946-1958," in Committee on Banking and Currency Subcommittee on Housing, U.S. Senate, Study of Mortgage Credit, Washington: GPO, 1958.
72. Smith, W.L. Interest Rates and Their Economic Implications, Conference on Savings and Residential Financing, 1966.

Advances a fixed rate hypothesis: interest ceilings on FHA and VA mortgages have interfered with free market processes and have intensified the impact of monetary policy on the housing sector.

73. Sparks, G.R. "An Econometric Analysis of the Role of Financial Intermediaries in Postwar Residential Building Cycles," in Determinants of Investment Behavior, R. Ferber, ed., New York: NBER, 1967.
74. Sparks, G.R. "A Model of the Mortgage Market and Residential Construction Activity," American Statistical Association, Proceedings, 1967.

Sparks attempts "to combine Mises's approach with a more detailed treatment of the supply of mortgage funds."

He develops a reduced form model of housing starts and flow of funds to financial intermediaries. His starts equations contains no credit terms but does include a mortgage supply term (actual loans and forward commitments). The start equation also includes a vacancy variable, a rent/cost ratio, household formation and income. The mortgage supply term in the start equation is derived from previously fitted equations on mortgage lending and commitment by financial intermediaries.

The demand for the flow of mortgage credit is assumed to depend on the same factors as housing starts. The demand for mortgage credit is never estimated directly. By substitution it is implicitly included in the equation for housing starts.

The model is estimated on annual data, from 1949-1964, by OLS.

The flow of funds to intermediaries is the major variable explaining mortgage lending and commitment.

Concludes that the supply of funds and household formations from the basis for explaining the cyclical behavior of housing.

75. Suits, D.B. "Forecasting and Analysis with an Econometric Model," American Economic Review, 1962, pp.104-32.

Starts equation is estimated over the 1947-1960 period, starts related to interest spreads. Expenditures equations estimated on lagged starts.

76. Swan, C. "A Quarterly Model of Housing Starts: A Disequilibrium Approach," Working Paper, 39, Federal Home Loan Bank Board, 1972.
77. Swan, C. "Housing Markets: An Aggregate View," Working Paper 40, Federal Home Loan Bank Board, 1972.
78. Swan, C. "Homebuilding: A Review of Experience," Brookings Papers on Economic Activity, 1970, pp.48-70.
79. Swan, C. "Housing Subsidies and Housing Starts," Federal Home Loan Bank Board, Working Paper 43, April 1973.

In the BFEA work, Swan proposes a simple reduced form starts equation, estimated on quarterly data over the 1958:3-1965:4 period. This model captures the 1966 housing trough but misses the 1969 one. Swan argues that the two experiences differ primarily due to changes

in a Maisel type basic demand. That is, the 1966 crunch was preceded by inventory accumulation and high vacancy rates, while household formation lead to a large shift in demand up to 1969, low vacancy rates and consequently an ameliorated impact. Differences in FHLB and FNMA actions may also have contributed to differences in the experience.

Develops a quarterly model of housing starts using Fair-Jaffee disequilibrium approach. Models demand and supply for starts, with actual starts determined by the smaller of the two. His disequilibrium variable is the mortgage interest rate which responds to excess demand or supply of housing starts.

Demand for housing starts is a function of logged mortgage interest rate, lagged vacancy rate (defined as deviation from normal vacancy rate using actual occupancy rate figures), and time trend (replacement and household formation). The supply of starts is really a supply of mortgage credit equation. Supply is a function of lagged mortgage interest rate, lagged savings inflows and FHLB advances to thrift institutions and a time trend (to deflate dollar volume of SFLWS).

In the demand for starts equation lagged mortgage interest rate and change in the mortgage interest rate have - sign, while in the supply equation mortgage interest variables and the flow of funds have a positive impact.

The model is quarterly, 1960:1 to 1970:4, estimated by OLS, with experiments on constraining the coefficient of mortgage interest rate.

Working Paper #40 presents simulation results of Swan's extension of Fair's model. Swan argues that FNMA is an important stabilizing influence in the mortgage market, although the model proxies FNMA only with time and interest variables. Subsidy programs and their possible linkages to the housing sector are discussed and preliminary simulations undertaken of their impacts.

FHLB paper No. 43 expands the disequilibrium model first presented in working paper to include an explicit treatment of subsidized units. Subsidy programs are assumed to shift the demand for starts but not the financial supply curve. (The time trend in the demand function is replaced by the measure of the stock of houses derived from data on households and occupancies rate.) Swan's estimates imply a highly elastic demand function and highly inelastic supply function. As a result increases in the subsidized housing programs have little net impact on the total number of starts as increases in the mortgage rate eliminate non-subsidized units.

80. Swan, C. "The Markets for Housing and Housing Services," Journal of Money, Credit and Banking, 1973, pp.960-972.

Comment on Arcelus-Meltzer article. Swan argues that in the housing literature, there is no implication that changes in mortgage credit affect the demand for housing services but the impact is on the natural number of starts. Emphasis is placed on savings flows and mortgages because of the extensive use of mortgage credit to purchase housing units and because of non-price rationing in mortgage markets.

81. Thygeson, K.J., "The Effect of Government Housing and Mortgage Credit Programs on Savings and Loan Associations," Occasional Paper #6, U.S. Savings and Loan League, 1973.
82. Tucker, D.P., "The Variable-Rate Graduated-Payment Mortgage," unpublished paper, Board of Governors of the Federal Reserve System, January 1974.
83. Van de Water, P. "Property Tax Incidence in the MPS Econometric Model of the United States Economy," unpublished Ph.D. Thesis, MIT, 1974.

Van de Water extends the present MPS structure (see Kalchbrenner) to include the combination of land and housing capital in the provision of housing services. Unlike the present reduced form estimation in the current model, Van de Water estimates supply and demand functions. He finds a high price elasticity of demand and significant credit rationing.

84. Wood, R. "Credit Terms and the Demand for Residential Construction,"
Study of Mortgage Credit, Committee on Banking and Currency,
Subcommittee on Housing, 1958.
85. Wharton Model (See M.D. McCarthy and M.D. Evans).

